

dem3d -- Windows 95 Display Software for DEM Data
Users Manual
(Software version 2.0b)
March, 1998

Neither the U.S. Government nor any agency thereof nor any of their employees make any warranty, expressed or implied, or assume any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed herein or represent that its use would not infringe privately owned rights. Reference to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the U.S. Government or any agency thereof.

1. Introduction

2. Terms and Menus

2.1 The Keyboard

- A. *Alt/Ctrl-Functions*
- B. *Number Pad Functions*

2.2 dem3d Menu Bar

- A. *File Menu*
- B. *View Menu*
- C. *DEM Menu*
- D. *Scene Menu*
- E. *Shaders Menu*
- F. *Tools Menu*
- G. *Help Menu*

2.3 dem3d Tool Bar

3. Opening a DEM

4. Changing Display Characteristics

4.1 Image Display

- A. *Change Resolution*
- B. *Change Vertical Exaggeration*
- C. *Surface Properties*
 - 1. *Shadows*
 - 2. *Render Type*
 - 3. *Highlights*
 - 4. *Manipulation View*

4.2 Display Environment

- A. *Camera Characteristics*
- B. *Light Source Characteristics*
- C. *Change Background Color*
- D. *Heads-Up-Display (HUD)*
- E. *Display Directions - Compass*
- F. *Display Base Wireframe Grid*
- G. *Display Water*

4.3 Display Attributes - Shaders

- A. *Daylight*
- B. *HSV*
- C. *Slope*
- D. *Interval*
- E. *Heading*
- F. *Terrace*

- G. Gradient
- H. Lake
- I. Anaglyph
- 5. Using the Tools
 - 5.1 Simple Camera
 - 5.2 Advanced Camera
 - 5.3 Move Light
 - 5.4 Adjust Water Level
 - 5.5 Vertical Exaggeration
 - 5.6 Visible Subset

1. Introduction

This manual is for *dem3d* Version 2.0. Earlier versions of the software may not contain all the features documented here. Later versions may contain additional features, or behave differently.

The *dem3d* software runs on Windows NT and Windows 95. It installs using the **run** option located on the start menu. A box will appear in which you type the name of the program and Windows will open it for you. Or, double-click on the downloaded file in Windows Explorer.

dem3d displays U. S. Geological Survey native format digital elevation models (DEM). The program is a simple viewer. Its purpose is to provide a quick and inexpensive data preview of USGS DEM data. It contains no editing, analysis, or other geographic information system (GIS) functions.

dem3d is public domain software and may be freely copied and distributed.

2. Terms and Menus

This section briefly reviews the menus and commands in order to understand the basic purpose of each. Figure 1 shows the program Menu Bar and Tool Bar as they appear upon startup.

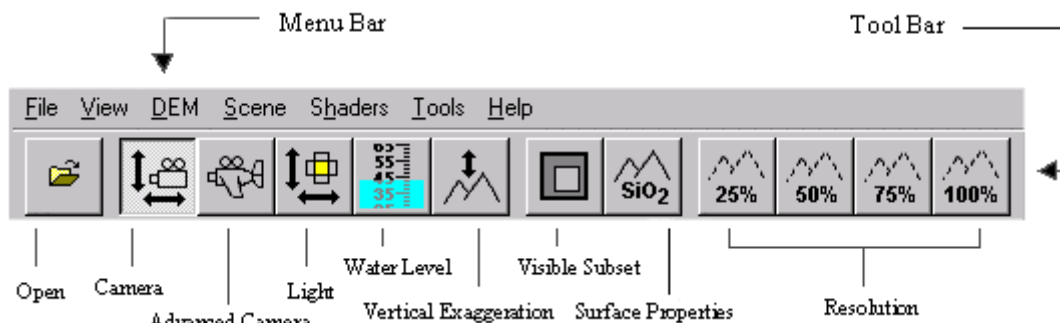


Figure 1. Menu and Tool Bar for dem3d

2.1 The Keyboard

A. Alt / Ctrl Functions

Although most interactions with dem3d are done with the mouse, a few commands and operations can be executed using the keyboard. Any commands that can be executed using the Ctrl or Alt keys in conjunction with another key are listed in parentheses following the command name.

B. Number Pad Functions

In version 2.0 the keys of the number pad serve special functions. The NUM LOCK light must be on to activate these functions. Keys 0 through 9 are camera position presets. They correspond to the direction displayed at the top, center position of the screen when the compass is turned on. By default they are:

| | | | |
|---|-----------|---|-----------|
| 0 | Top | 5 | Bottom |
| 1 | Northeast | 6 | West |
| 2 | North | 7 | Southeast |
| 3 | Northwest | 8 | South |
| 4 | East | 9 | Southwest |

New camera positions can be stored by holding the Ctrl key and pressing the number where the position is to be stored. It is recalled by pressing the number. The presets reset to the default each time a new DEM is loaded.

2.2 dem3d Menu Bar

A. File Menu (Alt-F)

Open (Ctrl-O) brings up a dialog box in which you may locate and select any existing file with the .dem extension.

Exit exits the dem3d application and closes the application window.

B. View Menu (Alt-V)

Toolbar toggles the display of the Toolbar window on-screen.

Status Bar toggles the display of the Status Bar at the bottom of the DEM viewer.

The Status Bar contains information about the XYZ coordinates of the mouse, the altitude and azimuth of the camera, the vertical exaggeration and the resolution of the DEM. In addition, it also shows the rendering progress when a DEM redraws itself.

C. DEM Menu (Alt-D)

Show Metadata opens a window with cartographic metadata from the currently opened file.

Resolution opens a window that allows the user to change the resolution of the currently displayed DEM.

Vertical Exaggeration opens a window that allows the user to manually set the vertical height of the currently displayed DEM.

Surface Properties opens a window that allows the user to change the render type and image highlights, choose how the DEM is displayed when being manipulated, and toggle the shadows on and off.

D. Scene Menu (Alt-S)

Camera opens a window to manually set the azimuth, altitude, and field of view for the camera.

Light opens a window to manually set the altitude and azimuth of the light source. It also allows the user to toggle whether the light icon is visible on the display.

Background opens a window to change the background color of the display.

HUD toggles the display of the Heads-Up-Display.

Compass toggles the display of the Compass.

Grid toggles the display of a flat grid beneath the elevation data.

Water toggles the display of a polygon that shows how the DEM would look if covered by water.

Captions toggles the display of the quadrangle name.

Options allows the user to change different features of the display environment. Currently, water is the only environment variable available for change.

E. Shaders Menu

Each of the commands listed in the Shaders Menu except for the **Options** command is a different way to view the elevation data. These will be explained in detail in Section 4.3.

Options allows the user to change different features of the shaders, such as display color and contour interval.

F. Tools Menu (Alt-T)

Simple Camera toggles the ability of the user to revolve and zoom in and out of the DEM on a center axis.

Advanced Camera toggles the ability of the user to do more advanced functions such as zoom in on a specific point other than the center.

Move Light allows user to change the light source by dragging the mouse.

Adjust Water Level allows the user to change the water level by dragging the mouse.

Vertical Exaggeration allows the user to change the vertical height of the displayed DEM by dragging the mouse.

Visible Subset allows the user to define a smaller area within the DEM to be displayed.

G. Help Menu

Help Topics - Online help is not implemented for this software version.

About dem3d opens a window to display the version of the software.

2.3 dem3d Tool Bar

Descriptions for all tools contained on the Tool Bar can be found in Chapter 2.1, Section F. See Figure 1 for the names that are associated with each icon.

3. Opening a DEM

Select the **file** icon from the Tool Bar or select [**File/Open**] from the Menu Bar. A standard Windows 95 **open** window will appear. The file list shows files with extension .dem by default. Highlight a file or type the name of the file in File name box. Click on Open.

4. Changing Display Characteristics

4.1 *Image Display*

A. Change Resolution

Select [**DEM/Resolution**] from the Menu Bar. A window with a slide switch appears. Grab the slider by clicking and holding with the left mouse button. Buttons are also available to change the resolution to an exact percentage. Increasing the resolution will improve image quality, but will also increase screen refresh times.

Resolution icons have been added to the tool bar for more convenience. Selecting either the **25%**, **50%**, **75%** or **100%** icon will change the resolution of the DEM to that exact percentage.

B. Change Vertical Exaggeration

Select [**DEM/Vertical Exaggeration**] from the Menu Bar. A window appears that allows the user to manually change the level of vertical exaggeration that the DEM displays. The maximum and minimum values are -10 and 10 respectively.

C. Surface Properties

Select the **SiO2** icon or select [**DEM/Surface Properties**] from Menu Bar. A window opens that allows the user to change the following properties:

1. Render type

Rendering is the actual process of drawing the data to the screen. The render type dictates the level of blending the DEM will have.

Flat shading uses simple rules to determine the intensity of the reflected light from the DEM. No smoothing is done, so the surface will retain its geometry at relatively high resolutions.

Smooth shading is a compromise between speed and visual quality. The DEM is shaded as with flat shading, but the colors of adjacent pixels in the same row are blended together. No blending is done between rows, which limits visual quality when zoomed in close.

Gouraud shading is a more sophisticated version of smooth shading. Image quality is better, but display times are longer. Technically, adjacent image pixels are polygon normal averaged at each vertex.

Wire frame shading shows the individual triangles that are used to represent the DEM. No blending or shading is done which results in a faster rendering time.

2. Highlights

A highlight is an area where light reflects off a surface without taking on the color of the surface. The location of a highlight depends on the position of the light source, the position of the observer, and the geometry of the reflecting surface. In the real world, highlights also depend on the physical characteristics of the reflecting surface.

The two slide switches on this option allow you to alter how large and how bright the highlights are.

3. Manipulation View

This gives the user a choice of whether to use a wire frame bounding box or a low-resolution approximation when manipulating the DEM, such as zooming or panning.

The low-resolution approximation is the default. However, selecting the box beside the command can turn it off. The resolution approximation is useful because it allows the user to see visually how they are manipulating the DEM, but it has a slower response time than the wire frame. The wire frame takes less time to draw, which may be an advantage on slower machines.

4. Shadows

Select the **Shadows** toggle to turn shadows on and off. Turning shadows off has the effect of giving the surface uniform illumination. Although this can be done with any shader (see section 4.3), it makes sense only for shaders that use different colors. The daylight shader, for example, becomes a featureless gray slab without shadows.

4.2 Display Environment

A. Camera Characteristics

The camera is the view of the user, as though a user is looking through the lens of the camera. Select [**Scene/Camera**] to change the view of the DEM. A window appears that allows the user to manually change the following properties:

1. Altitude

The altitude tells how high above the horizon the camera is located. If the altitude is at 0 degrees then the camera is level with the horizon. At an altitude of 90 degrees the camera is directly overhead, looking down on the DEM.

2. Azimuth

The azimuth is the compass position of the camera location relative to the DEM. For instance, if the camera is located at an azimuth of 0 degrees, the user is located north, looking due south. If the camera is located at azimuth of 90 degrees, the user is located east, looking west.

3. Field of View

The field of view is the angular area within the view of the camera. The angle is measured in degrees. The larger the measurement, the more of the DEM is visible. As the angle decreases, the view within the "camera lens" focuses on a smaller area, magnifying the image.

B. Light Source Characteristics

Select [**Scene/Light**] to change the position of the light source. A window appears that allows the user to manually change the following properties:

1. Altitude

The altitude tells how high above the horizon is the light source located. If the altitude is at 0 degrees then the light is level with the horizon, i.e. sunrise or sunset. At an altitude of 90 degrees the light is directly overhead.

2. Azimuth

The azimuth is the compass position of the light source location. If the camera is located at an azimuth of 0 degrees, the light is positioned in the north, directed due south. If the camera is located at azimuth of 90 degrees, the light is positioned in the east, directed west.

3. Light Source Display

The light position is shown on the display when [**Tool/Move Light**] is selected. To make the light position visible at all times, check the "Light icon always visible" box. There are times when the camera view and the light position are not compatible and the light icon will not be visible.

C. Change Background Color

The default background color is gray. To change the background color select [**Scene/Background Color**] from the Menu Bar. The change button brings up a menu of basic colors to choose from. Select a color and click [**Okay**].

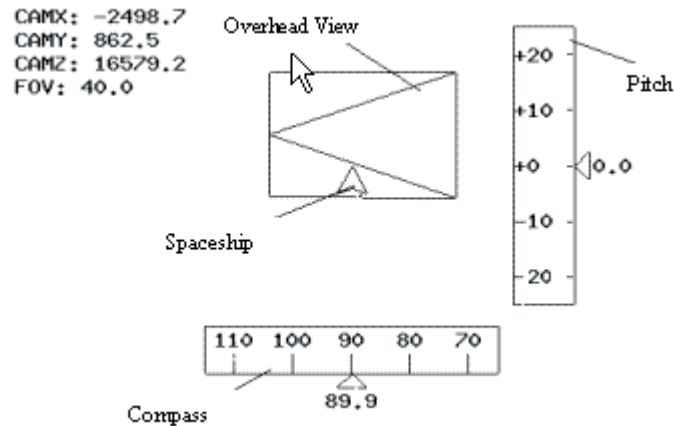
D. Heads-Up-Display (HUD)

The Heads-Up-Display allows the user to navigate around the elevation model without losing sight of where they are located in relation to the DEM. To turn on select [**Scene/HUD**].

There are three major features of the HUD:

1. Overhead view

This box represents the area of the DEM and the large arrow inscribed within it always points North. There is also a little "spaceship" that indicates the place that the user is located on the DEM.



2. *Compass*

The compass is located at the bottom of the screen. The compass shows the azimuth of the user's direction. For instance, if the compass says 270, then the user is facing West.

3. *Pitch*

The pitch is located on the right side of the screen. Imagine that the screen is the windshield of an airplane cockpit. The pitch is the angle that the nose of the plane makes with the horizon. So as the pitch decreases the user begins to look down.

Information such as the camera coordinates and the field of view are listed on the side.

Figure 2

E. Display Directions - Compass

To display labels for the eight primary compass points, select [**Scene/Compass**]. This is a toggle switch; to turn the direction labels back off, repeat the procedure. The compass points are either all displayed or not displayed.

F. Display Base Wireframe Grid

The software is able to display a flat grid below the elevation data. To turn this grid on, select [**Scene/Grid**]. This is a toggle switch; to turn the grid back off, repeat the procedure.

G. Display Water

To display water select [**Scene/Water**]. At the default value, a blue polygon will appear at the minimum elevation of the DEM. This is a toggle switch; to turn the water back off, repeat the procedure.

To change the color characteristics of the water command select [**Scene/Options**].

To set the water level to a specific elevation, type the elevation of the height of the water. The water level can also be changed interactively, see Section 5.4.

The slider bar from opaque to clear changes the intensity of the water. If the water is completely opaque, an outline of the DEM is not visible. However, if the water is completely clear then the DEM is totally visible underneath the water.

4.3 Display Attributes - Shaders

A "shader" is a way of coloring or shading a DEM. Some of the shaders assign different colors to different ranges of elevations. Some show steeper areas in one color and flatter areas in another. Different shaders often reveal different data characteristics or subtle detail that may be overlooked with conventional data representations. To use any of the shaders select [**Shaders/Name of Shader**].

Following are non-technical explanations of the shader algorithms used by *dem3d*. These explanations will make the most sense if read while trying them in the software.

A. *Daylight*

The daylight shader uses a single grayscale value for every elevation in the DEM. This shader comes closest to showing what the actual terrain would look like in a black and white aerial photo.

To change the surface color select [**Shaders/Options/Daylight**].

B. *HSV*

HSV stands for "hue, saturation and value." This shader chooses a range of colors from the HSV color space. These colors are then assigned to the DEM so that one end of the range corresponds to the lowest elevation in the DEM and the other end of the range corresponds to the highest. This shader is colorful, and is useful for bringing out detail in DEM's that have small differences between the minimum and maximum elevations.

C. *Slope*

This shader colors flat areas one color and vertical areas another color. An area with a slope between perfectly flat and perfectly vertical is shaded with a combination of the two colors. Technically, the colors are blended using a linear combination of the flat and steep colors proportional to the slope.

To change either the flat or slope color select [**Shaders/Options/Slope**].

D. *Interval*

Assigns colors to elevations from a fixed set of colors. In future versions of the viewer, the user will be able to select the colors and determine how the colors are mapped to the DEM.

E. Heading

This shader changes the surface color of the DEM depending on which direction water would flow downhill at that point.

F. Terrace

This shader is unusual because it alters the elevations in the DEM. The elevations are snapped to a user-specified elevation interval and colored one of two alternating colors before being drawn. This has the effect of creating crude contour lines.

To change the colors or other properties select **[Shaders/Options/Terrace]**. A window appears that allows the user to change the contour interval. This property defines the interval of elevation that appears between each color change. The user may also change the color of the elevation intervals and the edge color that clearly marks where the interval ends.

G. Gradient

Colors the lowest elevation in the DEM one color, the highest elevation another. Elevations in between are some combination of the colors used for the lowest and highest elevation. This shader is most useful when shadows are turned off (see "Surface Properties") and the DEM is viewed from above.

To change either the color the lowest or highest elevation select **[Shaders/Options/Gradient]**.

H. Lake

This shader shows flat areas in blue, and other areas in green. The effect is to highlight areas that might be water bodies. DEM's do not contain feature information, so there is no way to tell from the data whether or not these areas are really bodies of water.

I. Anaglyph

This shader creates an image in which the viewer is able to view depth and height, as though looking at a physical model of the DEM. To view the anaglyph, it is necessary to use red and blue "3-D glasses."

To change the distance between views select **[Shaders/Options/Gradient]**.

The distance between the views is used to represent the distance between the two superimposed images that make up the anaglyph. The default distance should be sufficient in most instances but smaller values work better as the camera is moved closer to the DEM.

5. Using the Tools

5.1 Simple Camera

The simple camera command contains the basic functions for rotating the DEM. To use the simple camera, select [**Tools/Simple Camera**] or select the **camera** icon from the tool bar.

| Mouse Button | Movement of Mouse | Movement of DEM |
|--------------------|-------------------|--|
| Left Mouse Button | Right / Left | Rotates DEM to the right/left |
| | Up / Down | Rotates DEM upwards and downwards |
| Right Mouse Button | Up / Down | Zooms in / out on central point of DEM |

5.2 Advanced Camera

The advanced camera allows more flexibility when viewing the DEM. To use select [**Tools/Advanced Camera**] or select the **airplane** icon from the tool bar. In order to understand the movement better, an analogy to flying a plane is used. The view of the screen is the view through the pilot's windshield when flying. When the nose of the plane goes to the left, the view of the terrain does not move in actuality, but moves to the right in relation to the nose of the plane. The software attempts to recreate this on the screen. When the left mouse button is pressed and the user moves the mouse to the left, the DEM moves to the right as though the user has turned his/her head to the left. This happens the same way when the mouse is moved up or down.

The right mouse button works differently. It allows you to move the camera closer to any point on the DEM, unlike the Simple Camera that only allows you to move in on the center. It also allows you to move parallel with the horizon by moving the mouse from left to right.

Another feature of the advanced camera is that you can move up and down parallel to a central vertical axis. This is achieved by using the shift and right mouse button together.

This tool is complicated and may be difficult to get used to. It is best to attempt the different directions with the mouse to understand the movement better.

| Mouse Button | Movement of Mouse | Movement of DEM |
|----------------------------|-------------------|-------------------|
| Left Mouse Button | Right / Left | Look right / left |
| | Forward / Back | Look up / down |
| Right Mouse Button | Right / Left | Move right / left |
| | Forward / Back | Zoom in / out |
| Shift + Right Mouse Button | Forward / Back | Move up / down |

5.3 Move Light

DEM shading is done from a simulated light source. To move the light source, select the **light** icon on the Tool Bar or [**Tools/Light Source**] from the Menu Bar, then drag the light source with the mouse.

The model used for the simulated light source is a sphere surrounding the DEM image. The light sits on the surface of this sphere, and may be dragged around on that surface.

5.4 Adjust Water Level

To adjust the water level, select the **water level** icon or [**Tools/Adjust Water Level**] from the menu bar. To raise the water level click and hold the left mouse button while moving the mouse forward. To lower the water level, move the mouse downward. The water is able to move between the minimum and maximum elevation of the DEM.

5.5 Vertical Exaggeration

The actual elevation of the data is shown by default and corresponds to the elevation value of 1.0. To change the level of exaggeration, select the **mountain** icon or [**Tools/Vertical Exaggeration**] from the menu bar. To stretch the data upward click and hold the left mouse button while moving the mouse forward. To compress the data, move the mouse downward. The vertical height is able to move between the minimum and maximum value of exaggeration.

5.6 Visible Subset

This tool allows the user to define a smaller area within the DEM to focus on. This is especially useful to view crevices or the sides of rock formations. To define a subset, select the **box** icon or [**Tools/Visible Subset**] from the menu bar. The box represents the DEM with the north side at the top of the screen. To define a subset of the DEM, click the left mouse button on one of the squares on the border of the box. Hold the left mouse button and move the mouse to where the edge of the subset will be.

The reset button is will redisplay the total DEM.